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Mission Highlights STS-71



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Docking Marks International Beginning

The historic mission of the Space Shuttle *Atlantis* docking with the Russian *Mir* space station will be remembered as the start of an international outpost. The two vehicles, one a space truck capable of hauling international modules and science experiments into orbit and the other a continuous workplace and home for humans in space, separated after five days with promises of future rendezvous from the Russian and American crews. "We have started with the mission of *Mir*-18, STS-71 and *Mir*-19, what is intended to be and what will be a very long program, a very fruitful program," STS-71 Commander Hoot Gibson said.

The mission marked the 100th human space flight launched by the United States, and the first time U.S. and Russian space ships had linked up since the Apollo-Soyuz Test Program almost 20 years previous. "This is a new step in the creation of something (Konstantin) Tsiolkovsky at one time had dreamed about. All of these dreams have been practically implemented and are being implemented," said *Mir* 18's Gennady Strekalov.

Gibson flew the Shuttle to a flawless docking with the *Mir* station at 8 a.m. CDT, June 29, 1995, above Ulan-Ude, Buryatia, in Russia. The two spacecraft were 216 nautical miles above the Lake Baykal region of the Russian Federation. Mission Specialist Greg Harbaugh then engaged the docking mechanism to firmly latch the spacecraft together, creating the single largest spacecraft ever to orbit with a total mass of almost one-half million pounds.



Mir 18 Commander Vladimir Dezhurov and *Atlantis* Commander Hoot Gibson join in a historic handshake across the threshold of the docked U.S. Shuttle and Russian space station.

Space Shuttle *Atlantis*

June 27-July 7, 1995

Commander: Robert L. "Hoot" Gibson

Pilot: Charles J. Precourt

Mission Specialists: Ellen S. Baker
Gregory J. Harbaugh
Bonnie Dunbar

Mir 19 Crew: Anatoly Y. Solovyev
Nikolai M. Budarin

Mir 18 Crew: Vladimir N. Dezhurov
Gennady M. Strekalov
Norman E. Thagard



Commander Gibson holds the docking target.

The *Atlantis*' landing on July 7, 1995, meant the end of a 115-day flight for Norm Thagard, giving him the American record for long-duration space flight. "This is the way a space station ought to work," Thagard said. "You have a space station and a good transport vehicle. Our Shuttle has solved some of the shortcomings of Mir space station which was lack of ability to transport things back to Earth at the end of the flight, and the space station has provided another goal and task and job for our Space Shuttle."

During the five days of docked operations, the combined crew conducted in *Atlantis*' Spacelab module a host of joint U.S. and Russian biomedical investigations looking in particular at the effects the Mir 18 crew's stay in microgravity had on their bodies.

By the time of the July 4 undocking at 6:09 a.m. CDT, more than one-half ton of water, along with 53 pounds of oxygen, and 80 pounds of nitrogen had been transferred to the space station, a cargo transfer effort requiring intensive cooperation by the crew on orbit and ground support teams in Houston and Moscow.

Before *Atlantis* undocked, Solovyev and Nikolai Budarin climbed into the Soyuz vehicle that had brought Thagard, Dezhurov and Strelakov to Mir, undocked it from Mir and kept station and video cameras rolling as the American Shuttle backed away from the Russian station.

"We have all three vehicles in sight at this point. In one of the simulations, the words 'cosmic ballet' came to mind and I guess that's where we are,"

Gibson said as he guided *Atlantis* away from Mir.

Gibson's final public farewell to his Mir 19 counterpart was a familiar one for sailors and aviators everywhere. "We wish you fair winds and following seas and soft landings. We will count the days until you come back and we get to see you again."

Mission events

On Tuesday, June 27, 1995, the Florida skies cleared to allow a flawless, on-time launch of *Atlantis* at 2:32 p.m. CDT on the historic 100th U.S. human space flight. The Shuttle crew immediately began maneuvering toward the Russian Mir space station for docking.

On day two, Hoot Gibson, Charlie Precourt and Bonnie Dunbar began activating the Spacelab module located in the aft section of *Atlantis*' payload bay. During the five days of docked Shuttle/Mir operations, that module supported the joint scientific and medical investigations designed to increase our knowledge of the human body and the microgravity environment of space.

The historic docking of the U.S. Shuttle and Russian space station was successfully accomplished on day three.

Work days four and five were used to transfer medical samples and other materials associated with the Mir-18 crew to *Atlantis* and equipment for the Mir-19 and future missions to the station. The *Atlantis* crew also filled Russian space agency tanks with excess water from the Shuttle and transported it to Mir.

Flight day six was filled with scientific and medical investigations in the Spacelab module which focused primarily on understanding how the cardiovascular system responds to microgravity. In addition, Mir 18 crew members Dezhurov, Strelakov and Thagard used a neck collar of sorts to mimic increasing and decreasing arterial pressure on the baroreceptor sensors located in the arteries of the neck. These sensors constantly monitor blood pressure and send messages to the brain to increase or decrease heart rate to compensate for rising or dropping blood pressure. This investigation may help

researchers understand and reduce the phenomenon of orthostatic intolerance, or lightheadedness, sometimes experienced by astronauts upon return to Earth.

During the last half of day six, medical investigations using the lower body negative pressure device were performed in the Shuttle's laboratory module. Thagard and Strelakov both underwent sessions in the device which decreases air pressure around the lower portion of the body to imitate the effect of gravity in pulling fluids to the legs.

On day seven, following a formal farewell ceremony, crews closed Mir's hatch at 2:32 p.m. and *Atlantis*' hatch at 2:48 CDT to prepare for the undocking of the united spacecraft. Then on day eight, the Soyuz spacecraft unlatched from Mir at 5:55 a.m. CDT followed by the *Atlantis* at 6:10 a.m. CDT.

Days nine and 10 were used to continue the medical experiments on the Mir-18 crew and prepare for the Shuttle's return to Earth.

Commander Gibson and Pilot Precourt guided *Atlantis* to a smooth touchdown at the Kennedy Space Center at 9:55 a.m. CDT to wrap up the first Shuttle/Mir linkup mission.

SMSP experiment summaries

The Shuttle Mir Science Program (SMSP) is a joint cooperative research program between the Russian and American space programs. With *Atlantis* docked to Mir, data and samples collected during the Mir 18 tenure were transferred to the Shuttle



Baker monitors Strelakov during a treadmill run.

for the return trip to Earth. The research conducted on STS-71 as part of the SMSP involved 15 joint US/Russian Science investigations in seven disciplines. This research was designed to maintain the health of crewmembers and provide a greater understanding of human immunity, to advance medical knowledge.

The six metabolic research experiments examined a wide range of physiologic responses to aid in understanding how the body's mechanisms work in space, and how gravity affects the body on Earth. Investigators studied human metabolism and endocrinology and investigated how fluids redistribute themselves in the body and how microgravity affects bone density and red blood cell production. Crew members also participated in studies designed to determine if prolonged exposure to microgravity affects the body's ability to mount an antibody response and whether immune cells are altered by exposure to microgravity.

Researchers also measured changes in blood volume during flight and the pooling of blood in the legs and abdomen upon reentry to investigate the deconditioning of the cardiovascular and pulmonary systems. Exercise and the use of both Russian and American lower body negative pressure units were used as tests and evaluated as countermeasures. Using a device to mimic increasing and decreasing arterial pressure by applying suction and pressure to the neck, crew members provided information about heart rate response to changing pressure stimulus during and after space flight.

STS-71 took a look at neuromuscular function and muscle deconditioning during extended spaceflights. Crew members measured muscle tone, strength and endurance by electromyography and utilization of oxygen during treadmill and other exercises.

Two investigations looked at the radiation environment experienced during an extended stay in space, and others looked at the presence of microbes or trace chemicals found in the air and water consumed by the astronauts. Microbial samples were studied to see if microgravity or the characteristics of the closed environment affected microbial

physiology or their interactions with the crew on orbit.

Data from tests to study the long-term effects of microgravity on muscle coordination and mental acuity, collected during more than 3 months on Mir 18, were returned to Earth aboard *Atlantis*. A Russian spacecraft control simulator used before, during and after flight allowed researchers to measure crew members' functional state and manual control performance.

Crew members also studied how weightlessness affects embryo development by returning to Earth a set of pre-fertilized quail eggs incubated on board Mir. The incubation process was stopped at various stages of development, and the embryos placed in a fixative solution for later analysis.

A protein crystal growth experiment was carried aboard STS-71 and transferred to the Mir to continue the observance of crystallization of a number of large proteins that may be used in basic biological research, pharmacology and drug development. The Space Acceleration Measurement system, flown frequently on the Shuttle, will be in place on Mir to measure any motion caused by crew activity or engine firings. This information aids scientists in determining the best location to house protein crystal growth experiments in order to produce the purest possible samples.

Additional payload descriptions

IMAX: NASA uses the IMAX film medium to document its space activities and better translate them to the public. This system, developed by IMAX Systems Corp., Toronto, Canada, uses specially designed 70mm film cameras and projectors to record and display very high definition, large screen pictures. The IMAX system on STS-71 consisted of a camera, lenses, rolls of film, lights,

and other equipment that is necessary for filming. The equipment was stowed in the middeck of the Orbiter for in-cabin use. The IMAX used two film magazines that could be interchanged as part of the operation; each magazine runs for approximately three minutes. Each time the crew used both magazines, they reloaded with new film. Lenses were changed as necessary based on the shot.

SAREX-II: Students in the U.S. and Russia had a chance to speak via amateur radio with astronauts aboard the *Atlantis* during STS-71. Space Shuttle Pilot Charlie Precourt and Mission Specialist Ellen Baker talked to students in five schools in the U.S. and Russia. The radio contacts were part of the Shuttle Amateur Radio Experiment (SAREX) project, a joint effort by NASA, the American Radio Relay League and the Radio Amateur Satellite Corporation.

Crew biographies

The STS-71 crew was comprised of primarily veteran U.S. astronauts and cosmonauts which brought more than 15,000 hours of combined space experience to the first Shuttle/Mir docking mission.

Commander: Robert L. "Hoot" Gibson (Capt. USN). Gibson, 48, was born in Cooperstown, New York, but



Traditional in-flight crew portrait features clockwise starting at the six o'clock point, Greg Harbaugh, Hoot Gibson, Charlie Precourt, Nikolai Budarin, Ellen Baker, Bonnie Dunbar, Norm Thagard, Vladimir Dezhurov, Gennady Strekalov and Anatoly Solovyev.



Mission Specialist Greg Harbaugh taking care of business on *Atlantis*' middeck.

considers Lakewood, California, to be his hometown. He received an associate degree in engineering science from Suffolk County Community College in 1966 and a bachelor's in aeronautical engineering from California Polytechnic State University in 1969.

Gibson entered active duty with the Navy in 1969. He is a graduate of the Naval Fighter Weapons School, Topgun, and the U.S. Naval Test Pilot School, Patuxent River, Maryland.

Selected as an astronaut in 1978, Gibson's first spaceflight was as pilot of STS-41B in February 1984. The flight accomplished the deployment of two communications satellites and tested rendezvous sensors and computer programs for the first time.

He next flew as commander of STS-61C, a six-day flight that included the deployment of the SATCOM KU satellite and experiments in astrophysics and materials processing.

Gibson's third trip to orbit was made in December 1988 on STS-27, a classified Department of Defense mission. He then returned to space for a fourth time on STS-47 in September 1992. The mission was a cooperative venture between the United States and Japan, focusing on more than 40 life science and materials processing experiments. At the completion of his fifth flight, STS-71 Gibson has logged more than 36 days in space.

Pilot: Charles J. Precourt (Lt. Col, USAF). Precourt, 39, was born in Waltham, Massachusetts, but considers Hudson, Massachusetts, to be his hometown. He earned a bachelor's degree in aeronautical engineering from the U.S. Air Force Academy in 1977, and master's degrees in engineering management from Golden Gate University, and national security affairs and strategic studies from the U.S. Naval War College in 1988 and 1990, respectively. While at the Air Force Academy, Precourt also attended the French Air Force Academy in 1976 as part of an exchange program.

Precourt graduated from Undergraduate Pilot Training at Reese Air Force Base, Texas, in 1978. In 1985, he attended the U.S. Air Force Test Pilot School at Edwards Air Force Base, California. Upon graduation he was assigned as a test pilot at Edwards until mid-1989, when he began studies at the U.S. Naval War College.

Precourt was selected as an astronaut candidate in 1990. His technical assignments have included duties in the Astronaut Office Operations Development Branch, working on ascent, entry and launch abort issues. Precourt flew his first space mission as a mission specialist on STS-55 in April 1993. The German-sponsored mission included almost 90 experiments designed to investigate life sciences, material sciences, physics, robotics and astronomy. At the conclusion of STS-71, he had spent more than 475 hours in orbit.

Mission Specialist: Ellen S. Baker (M.D.). Baker, 42, was born in Fayetteville, North Carolina, but considers New York City to be her hometown. She received a bachelor's degree in geology from the State University of New York at Buffalo and a doctorate of medicine degree from Cornell University in 1978. After completing medical school, Baker trained in internal medicine at the University of Texas Health Science

Center, San Antonio, Texas. In 1981, she was certified by the American Board of Internal Medicine.

Following her residency, Baker joined NASA as a medical officer at the Johnson Space Center. That same year she graduated from the Air Force Medicine Primary Course at Brooks Air Force Base in San Antonio, Texas. Selected as an astronaut candidate in 1985, her technical assignments have included working with flight crew procedures, flight software verification, operations and engineering support activities and space station operation issues. She also has served as chief of the Astronaut Appearance Office.

Baker has logged more than 686 hours in space. Her first mission was STS-34 in October 1989 which successfully started the Galileo spacecraft on its journey to Jupiter. Her second mission was STS-50 in June/July 1992. The STS-50 crew spent about two weeks in orbit to conduct a series of scientific experiments involving crystal growth, fluid physics, fluid dynamics, biological science and combustion science.

Mission Specialist: Gregory J. Harbaugh. Harbaugh, 39, was born in Cleveland, Ohio, but considers Willoughby, Ohio, his hometown. He earned a bachelor's degree in aeronautical and astronautical engineering from Purdue University, and a master's degree in physical science from the University of Houston-Clear Lake City, Texas.

Since 1978, Harbaugh has held engineering and technical management positions in Space Shuttle flight operations at the Johnson Space Center. He also supported missions as a Data Processing Systems Officer from the Mission Control Center for most of the first 25 Shuttle flights.

Selected as an astronaut in June 1987, Harbaugh's technical assignments have included work with the Shuttle Avionics Integration Laboratory, the Shuttle Remote Manipulator System and telerobotics systems development for space station. He also supported the Hubble Space Telescope servicing mission development and extravehicular activity assessment for the International Space Station.

Harbaugh's first mission, STS-39 in April/May 1991, was an eight-day



Solovyev, left, and Budarin perform a communications check on the Soyuz in preparation for undocking to capture pictures of the Atlantis/Mir undocking.

unclassified Department of Defense mission involving research for the Strategic Defense Initiative. His second flight was STS-54 in January 1993 which the TDRS-F satellite was deployed and Harbaugh participated in a 4-hour, 28-minute space walk. Harbaugh has now logged more than 578 hours in space.

Mission Specialist: Bonnie Dunbar (Ph.D.). Dunbar, 46, a native of Sunnyside, Washington, received bachelor's and master's degrees in ceramic engineering from the University of Washington; and a doctorate in biomedical engineering from the University of Houston.

Dunbar worked for Boeing Computer Services as a systems analyst and was invited to participate in research at Harwell Laboratories in Oxford, England, as a visiting scientist. She accepted a senior research engineer position with Rockwell International Space Division in Downey, California, where her responsibilities included developing equipment and processes for the manufacture of the Space Shuttle thermal protection system.

In 1978, Dunbar accepted a position as a payload officer/flight controller at the

Johnson Space Center. Selected as an astronaut in 1981, Dunbar is a veteran of four space flights logging more than 997 hours in space. Her first flight, STS-61A, was a cooperative Spacelab mission with West Germany. The payload included more than 75 scientific experiments in the areas of physiological sciences, materials science, biology and navigation. In January 1990, Dunbar served as a mission specialist on STS-32 which deployed the Syncom IV-F5 satellite and retrieved the Long Duration Exposure Facility.

On her third mission, Dunbar served as payload commander for STS-50 in June/July 1990. The crew of the 13 day mission conducted experiments in scientific disciplines such as protein crystal growth, electronic and infrared detector crystal growth, surface tension physics, zeolite crystal growth and human physiology.

Mir 19 Commander: Anatoly Y. Solovyev. Solovyev, 47, served from 1972 to 1976 as a senior pilot and group commander in the Far Eastern Military District. Since August 1976, he has been a student-cosmonaut at the Yuri A. Gagarin Cosmonaut Training Center, completing his general space training in 1979. He is a test pilot third class and a test cosmonaut.

In 1988, he was the commander of a Soviet-Bulgarian crew for an expedition that visited the Mir station. The flight lasted nine days. From Feb. 11 to

Aug. 9, 1990, Solovyev accomplished a 179-day flight on board the Mir orbital complex as commander for the sixth primary expedition. During the mission, the crew conducted a series of technological, geophysical and biomedical investigations; performed two spacewalks; and placed the Kristall module into service.

Solovyev's third flight was a 189-day mission to Mir. Mission activities included the completion of a Russian-French science program with

microgravity, biology, medical, biotechnology and other investigations.

Mir 19 Flight Engineer: Nikolai M. Budarin. Budarin, 42, received a mechanical engineering degree from the S. Ordzhonikidze Moscow Aviation Institute in 1979. He then joined NPO Energia where he was involved in experimental investigations and testing of space technology.

In 1989, Budarin was enrolled in a cosmonaut detachment as a candidate test cosmonaut, completing his training in 1991. He is a qualified test cosmonaut.

Mir 18 Commander: Vladimir N. Dezhurov (Lt. Col, Air Force). Dezhurov, 32, was born in the Yavas settlement of the Zubovo-Polyansk district in Mordovia, Russia, Dezhurov graduated from the S.I. Gritsevits Kharkov Higher Military Aviation School in 1983 with a pilot-engineer's diploma. After graduating, he served as a pilot and senior pilot in the Russian Air Force. In 1987, he was assigned to the Cosmonaut Training Center and underwent the general space training from December 1987 to June 1989. Since then he has continued training as a member of a group of test cosmonauts. He was also a correspondence student at the Yuri A. Gagarin Air Force Academy beginning in 1991.



Thagard displays the flight suit he wore during his 115 days on Mir.

STS-71 Quick Look

Launch Date: June 27, 1995
Launch Site: KSC Pad 39A
Launch Time: 3:32 P.M. EDT

Orbiter: *Atlantis*
(OV-104)
14th flight

Orbit/Inc.: 213 nautical miles
51.6 degrees

Mission Duration: 9 days,
19 hours,
22 minutes

Landing Date: July 7, 1995
Landing Time: 10:55 a.m. EDT
Landing Site: Kennedy Space Ctr.

Crew: Robert "Hoot" Gibson, (CDR)
Charlie Precourt, (PLT)
Ellen Baker, (MS1)
Greg Harbaugh, (MS2)
Bonnie Dunbar, (MS3)
Anatoly Solovyev, (Mir 19
CDR)
Nikolai Budarin, (Mir 19

Flight Engineer)
Vladimir Dezhurov, (Mir 18
CDR)
Gennady Strekalov, (Mir 18
Flight Engineer)
Norm Thagard, (Mir 18
Cosmonaut- Researcher)

EVA: Harbaugh (EV1), Baker (EV2)

Cargo Bay Payloads: Spacelab-Mir
Orbiter Docking System

Middeck Payloads: IMAX

In-Cabin Payloads: SAREX-II

Aug. 1 to Dec. 10, 1990, Strekalov completed his fourth space flight as the flight engineer on the seventh primary expedition to the Mir orbital complex. At the completion of that flight, he had accumulated 153 days in space.

Cosmonaut Researcher: Norman E. Thagard, M.D. Thagard, 51, was born in Marianna, Florida, but considers Jacksonville, Florida, to be his hometown. He received bachelor's and master's degrees in engineering science from Florida State University.

In September 1966, he entered active duty with the U.S. Marine Corps Reserve. Thagard received a doctor of medicine degree from the University of Texas Southwestern Medical School in 1971, and interned in the Department of Internal Medicine at the Medical University of South Carolina.

Thagard was selected as an astronaut in 1978. His first space mission was STS-7 in June 1983 which deployed two satellites, deployed and retrieved the Shuttle Pallet Satellite, and conducted a series of scientific investigations. His second flight was STS-51B, the Spacelab-3 science mission, in April/May 1985. Thagard's duties on the mission included deploying the NUSAT satellite, caring for animals in the Research Animal Holding Facility and operating a variety of other experiments.

Thagard went to orbit for a third time in May of 1989 on STS-30 which deployed the Magellan probe. His fourth flight in January 1992 was STS-42. The flight, called the International Microgravity Laboratory-1 mission, featured 55 experiments from 11 countries, which studied the effects of microgravity on material processing and life sciences.



The STS-71 crew patch design depicts the *Atlantis* in the process of the first international docking mission of the Space Shuttle with the Russian space station Mir. The names of the 10 astronauts and cosmonauts who flew aboard *Atlantis* are shown along the outer border of the patch. The rising sun symbolizes the dawn of a new era of cooperation between the two countries. The *Atlantis* and Mir are shown in separate circles converging at the center of the emblem symbolizing the merger of space programs from two spacefaring nations. The flags of the United States and Russia emphasize the equal partnership of the mission. The joint program symbol at the lower center of the patch acknowledges the extensive contributions made by the Mission Control Centers of both countries.

With the 115 days aboard Mir, Thagard has logged more than 142 days in space.

Mir 18 Flight Engineer: Gennady M. Strekalov. Strekalov, 54, was born in Mytishchi in the Moscow Region of Russia, and graduated from the N.E. Bauman Moscow Higher Technical School in 1965 with an engineer's diploma. Since then, he has worked at Energiya and has been involved in experimental investigations and the testing of space technology.

Strekalov's first space flight was a two week mission in 1980 to the Salyut space station, completing an experimental flight aboard the Soyuz T-3 spacecraft. He visited Salyut again in April 1983 and in April 1984. From